TEST PLAN
for
WATER TREATMENT SYSTEM
EVALUATION AT RMA

by

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13. ABSTRACT *(Maximum 200 words)*

TREATABILITY WORK ON CONTAMINATED GROUND WATER AT RMA WAS INITIATED BY WES IN FY77, AND CONTINUED IN FY78. ACTIVATED CARBON ADSORPTION AND UV/OZONE OXIDATION WERE BOTH FOUND TO EFFECTIVELY REMOVE ORGANIC CONTAMINANTS FROM THIS WATER. DUE TO IMMEDIATE AVAILABILITY OF EQUIPMENT, ACTIVATED CARBON WAS CHOSEN FOR THE PILOT CONTAINMENT/TREATMENT SYSTEM AT THE NORTHERN BOUNDARY. NO REQUIREMENT FOR INORGANIC TREATMENT HAS BEEN NEEDED AT THE NORTH BOUNDARY. INTEREST IN GROUND WATER TREATMENT NEAR SUSPECTED CONTAMINATION SOURCES LED TO TREATABILITY STUDIES ON WATER FROM WELL 118 (NEAR BASIN F) IN FY78. A HIGH CONCENTRATION OF INORGANIC CONTAMINANTS WAS FOUND IN THIS WATER. PRELIMINARY TREATABILITY STUDIES WITH CARBON AND UV/OZONE INDICATED AN INTERFERENCE PROBLEM WITH THE PRECIPITATION OF METAL HYDROXIDES. THIS PRELIMINARY WORK ESTABLISHED A NEED FOR A VERY VERSATILE TREATMENT PROCESS SYSTEM INCORPORATING BOTH ORGANIC AND INORGANIC TREATMENT. EQUIPMENT FOR A FIELD-SCALE SYSTEM WAS CONSTRUCTED AND SET UP AT RMA IN ORDER TO EVALUATE DIFFERENT PROCESS TRAINS. THIS EVALUATION AND

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INTRODUCTION

1. Groundwater at Rocky Mountain Arsenal (RMA) has been found to contain certain inorganic and organic contaminants as a result of various past and ongoing activities at the arsenal. Treatability work on groundwater was initiated by the Waterways Experiment Station (WES) in FY 77 and continued in FY 78. The groundwater initially studied was characteristic of that at the northern boundary of the arsenal. Activated carbon adsorption and UV/ozone oxidation were both found to effectively remove organic contaminants from this water. Due to the immediate availability of equipment, activated carbon was chosen for the pilot containment/treatment system at the northern boundary. A Calgon carbon system was installed in FY 78 and has operated successfully for several months. No requirement for inorganic treatment (except possibly for fluoride) has been needed at the northern boundary.

2. Interest in groundwater treatment near suspected contamination sources led to an initiation of treatability studies on water from Well 118 (near Basin F) in FY 78. A high concentration of inorganic contaminants was found in this water. Preliminary treatability studies with activated carbon and UV/ozone indicated an interference problem associated with the precipitation of metal hydroxides (particularly iron and manganese). The precipitate could plug the carbon beds lowering the efficiency of the adsorption process and it could interfer with the transmittance of the UV light thus lowering the efficiency of the oxidation process.

3. This preliminary work established a need for a very versatile treatment process system incorporating both organic and inorganic treatment that could be used on different source waters at RMA and on wastewaters from other Army installations. A treatment scheme was developed (Figure 1) incorporating pretreatment (for inorganics), primary treatment (for organics), post treatment (for contaminants not removed by the first two), and side-stream treatment and disposal for process water. A research and development program was initiated during FY 78 to develop processes suitable for use as pretreatment and primary treatment. This work was conducted on Well 118

water. Chemical addition and precipitation were chosen for the pretreatment process. Activated carbon and UV/ozone were chosen for the primary treatment process. Equipment for a field scale system was constructed and set up at RMA in order to evaluate different process trains. This evaluation and optimization of the treatment process will be conducted in FY 79. This test plan presents the combination system work to be performed.

OBJECTIVES

4. The objectives of this study are as follows:

   a. Assess the potential of the treatment system in removing inorganic and organic contaminants from various RMA source waters.

   b. Testing of individual inorganic/organic processes to determine optimal configurations of pretreatment, primary treatment, post treatment and side stream disposition unit operations on the identified source waters.

   c. Provide operating data and costs associated with various process trains.

   d. Refinement of operational models for the treatment processes based on the data obtained.

MATERIALS AND METHODS

Equipment

5. The equipment for the pretreatment process includes mixers, mixing tanks, chemical feed pumps, and modified ERDA lator (upflow clarifier), and a storage tank. The pretreatment unit has been constructed and checked-out and is ready for use.

6. The UV/ozone treatment unit to be used initially is a single vessel, mechanically-mixed reactor (Figure 2). The reactor vessel is constructed of stainless steel and contains a variable speed impeller mixer. The reactor has four quartz tubes placed so as to surround the mixer impeller. Various UV lamps can be placed in these tubes. The unit allows for variable control of temperature, pH, pressure, and recycle along with the standard operational parameters. The unit is completely contained, skid mounted and highly portable.

7. The equipment to be used for activated carbon evaluation includes jars and stirrers for adsorption isotherm testing and various size columns for use in determining breakthrough characteristics. Various types of carbon are available for evaluation.

8. All the equipment is configured so as to be portable and to permit the interconnecting of each unit operation. These alternate test configurations will be discussed in the next section.

Field System Operation

9. The field system operation will incorporate the evaluation of three different treatment scenarios: (a) pretreatment followed by carbon (b) pretreatment followed by UV/ozone, and (c) pretreatment followed by a combination of UV/ozone and carbon.

10. Initially, effluent from the pretreatment unit will flow to a storage tank. Water will be taken from the storage tank for both carbon and UV/ozone treatment tests so that water used in each test is identical. Work on carbon adsorption and UV/ozone treatment will be done simultaneously.

11. In the carbon studies, pretreated water will be subjected to standard isotherm testing with the tests being conducted at different pH levels to determine optimum pH levels, best carbon type, and adsorption capacity of the carbon for various organic contaminants. At the completion of the isotherm tests, small columns will be set-up for evaluation of breakthrough of the contaminants for the activated carbon. With this information and cost information from the vendors, an evaluation of efficiency and costs for this treatment scenario will be provided to the OPM-CDIR. This work will be conducted by RMA personnel with technical assistance being provided by WES.

12. For the UV/ozone studies, water will be taken from the storage tank and passed through the UV/ozone reactor. Operational parameters will be adjusted until optimum conditions can be determined. This will be achieved by use of a factorial type experiment that lends itself to statistical analysis. The study will begin with a series of runs designed to evaluate the correlation between the field unit and the laboratory unit. The runs will be made on pretreated Well 118 water due to the data available from the lab unit on this water. These correlation data will be used to determine

the correlation factors between the two units so that in the future, any laboratory work done can be applied to the field through use of the developed factors. With the operational information generated combined with equipment and power costs, an evaluation of efficiency of the process along with costs for this treatment scenario will be provided to the OPM-CDIR. This work will be conducted by WES personnel with operational support from RMA.

13. In the combined UV/ozone and carbon work, effluent from the UV/ozone reactor using various retention times will be obtained, adsorption isotherms and breakthrough column studies will be conducted on the effluent samples to determine the effect on the adsorptive rate and capacity of the carbon. When this work has been completed, the UV/ozone reactor and carbon columns will be configured in series and the operational studies will be initiated. The best retention times and carbon operational parameters found in the preliminary work will be used initially and then the operational parameters of both systems will be checked to insure optimum efficiency. In order to minimize the costs for the combination system, the flow rate through both systems must be maximized (reduction in capital costs) and the sum of the power costs for UV/ozone (dependent upon the retention time) and the regeneration costs for the carbon (dependent on the organic loading to the carbon bed) must be minimized. At the conclusion of this work, process efficiency and costs for this treatment scenario will be provided to the OPM-CDIR. This work will be conducted jointly by WES and RMA personnel with technical supervision being provided by the WES project engineer.

14. Some work will be required in the area of sidestream treatment and disposal. This work will include carbon regeneration studies and sludge disposal from the pretreatment unit. Any carbon regeneration studies will probably be done by a vender. This work would determine the compatability of the adsorbed organic contaminants with the regeneration process and the suitability of the carbon for reuse after regeneration. The sludge disposal work will incorporate studies on dewaterability, solids handling, leaching potential, and suitability for chemical fixation (if required). This work will probably be done at WES.

Sampling and Analysis

15. The field system will be instrumented to facilitate continuous monitoring of operating parameters. Parameters to be monitored include:

a. Ozone concentration (UV/ozone unit only)

b. pH

c. Liquid and gas flow rates

d. Temperature

16. As in previous studies, DIMP will probably be used as a representative constituent on which to base treatment efficiency. Analyses will be conducted as follows:

a. Organic

(1) DIMP

(2) DCPD

(3) Nemagon

(4) Pesticides

(5) Organosulfur compounds

(6) Organophosphorus compounds

(7) TOC (Total Organic Carbon)

(8) COD (Chemical Oxygen Demand)

b. Metals

(1) Iron

(2) Lead

(3) Mercury

(4) Arsenic

(5) Manganese

(6) Sodium

(7) Calcium

(8) Magnesium

c. Others

(1) Total dissolved solids

(2) Conductivity

(3) Chloride

(4) Fluoride

(5) Hardness

(6) Alkalinity

(7) Sulfate

(8) Nitrate

(9) Phosphate

The aforementioned analyses will be conducted throughout the study. Not all analyses will be conducted on every sample, but sufficient testing will be conducted to insure a thorough characterization of the different source water samples. Samples will be collected and analyzed according to Standard Methods.

17. The Analytical Laboratory Group (ALG) at WES will conduct metal analysis on the various samples. The Material Analysis Laboratory Division (MALD) at RMA will be responsible for organic analysis of samples except for COD. WES personnel will be responsible for any other analyses to be performed on site. Approximately 50 to 60 samples per week will be submitted to MALD for DIMP analysis while the field system is in operation. Approximately 10 to 15 samples per week will be submitted for analysis for the remaining organic species. Approximately 10 to 15 samples per week will be submitted to ALG for metal analysis and quality control. This analytical requirement supersedes any previously stated requirement.

SCHEDULING

18. A time schedule for operation of the water treatment system and combination studies at RMA during FY 79 is presented in Figure 3. The field studies on Well 118 are scheduled to continue through April 1979. The laboratory studies on Well 118 are scheduled to continue through December 1978. The laboratory work will then continue using water from the Basin A area; the work to be finished in late April 1979. The field studies on Basin A source water will be initiated in April 1979 and continue through the year. The work on Basin A area water can probably be initiated sooner if the Contamination Survey identifies a suitable well for procuring water at an earlier date than scheduled. Additional laboratory work will be conducted starting in April 1979 and continuing through the year on other source waters identified as a result of the Contamination Survey. Work is also scheduled in the expanded north boundary area if needed during the

May through September 1979 time frame. A final summary report on work completed in FY 79 is due 1 October 1979. Other data and information will be provided to the OPM-CDIR throughout the year as requested.

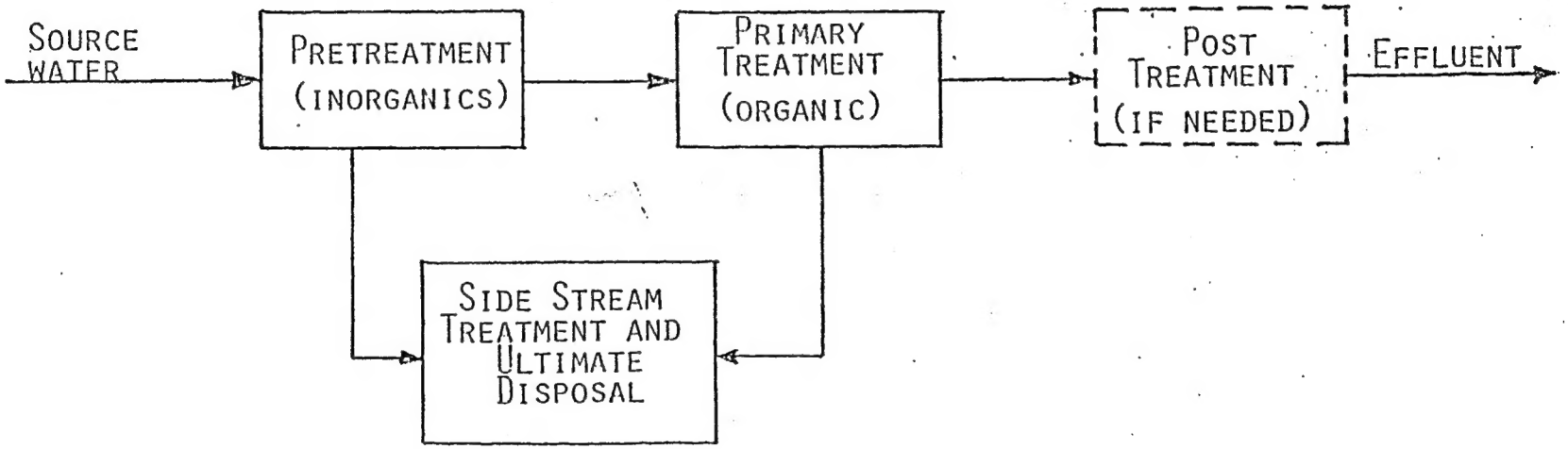

FIGURE 1. IR/RMA WATER TREATMENT SYSTEM

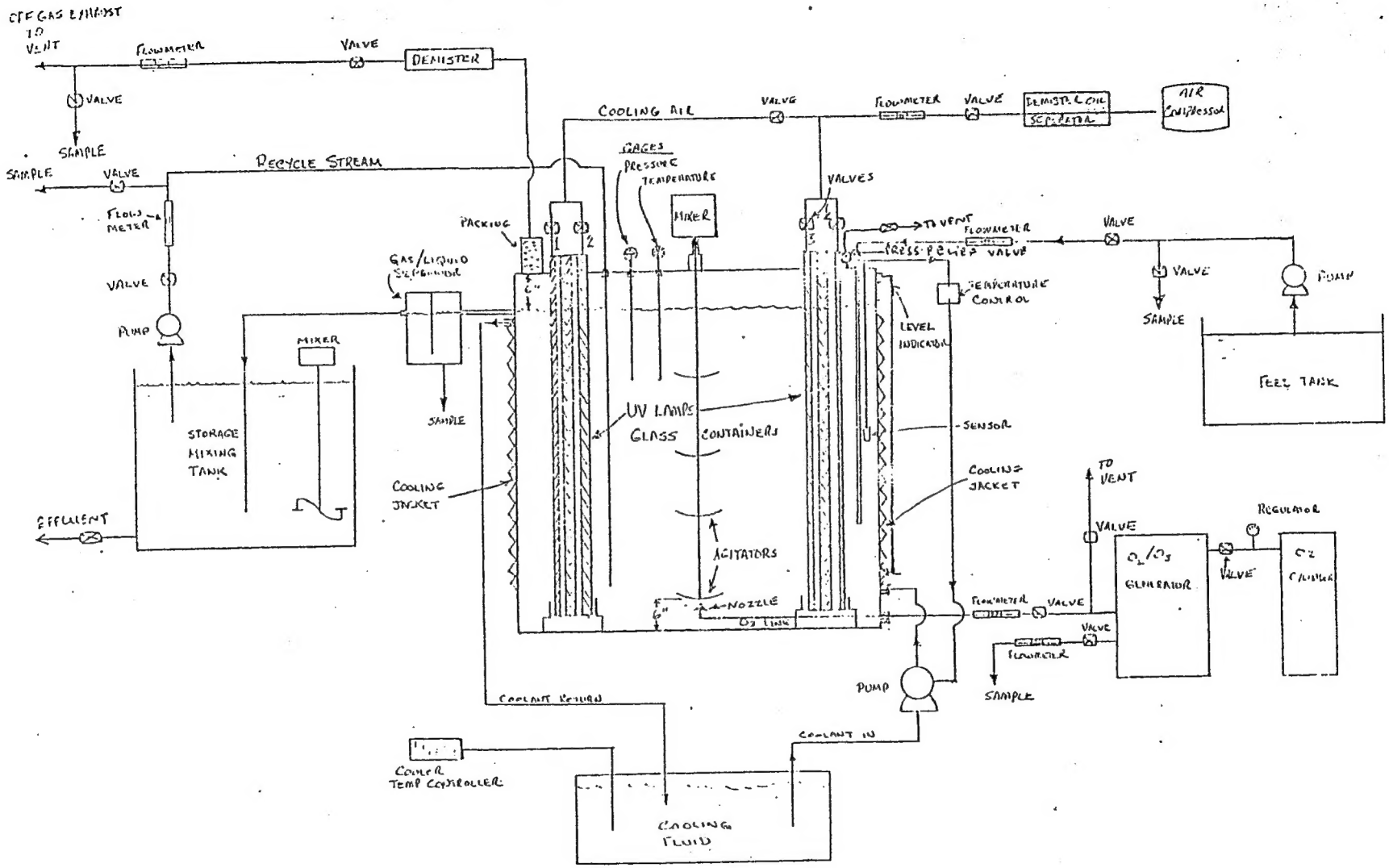

Figure 2. UV/Ozone Field Unit

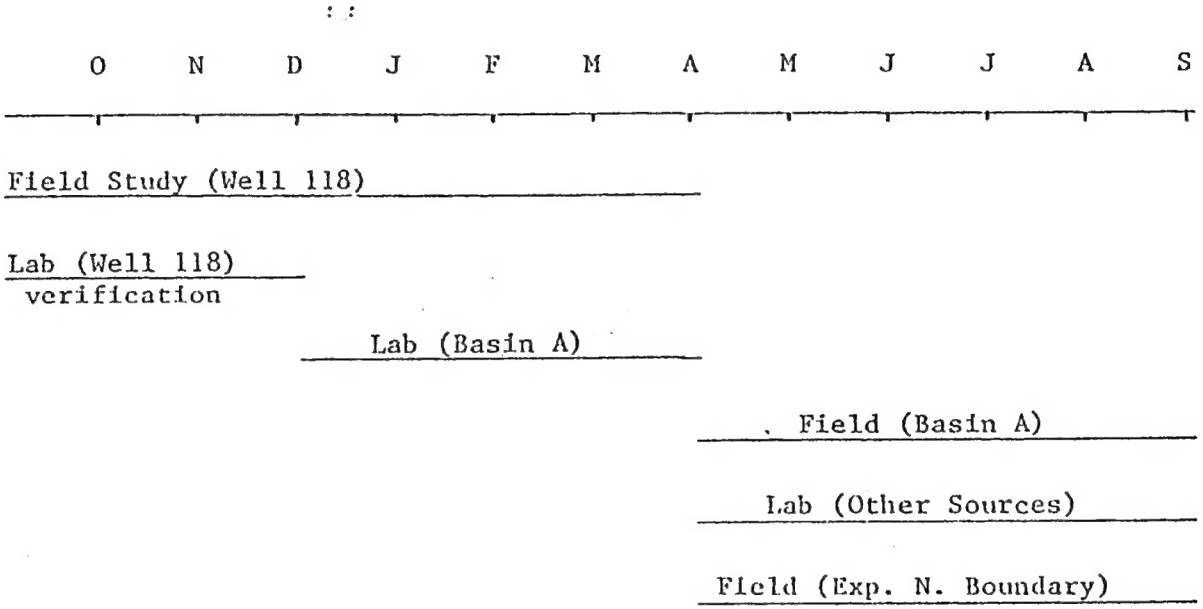

Figure 3. Combination Studies Schedule (FY 79)